Report on the Radio Testing

For

Sonetics Corporation

on

Connect

Report no. TRA-049218-47-02B

20th November 2020

Report Number: TRA-049218-47-02B
Issue: B

REPORT ON THE RADIO TESTING OF A
Sonetics Corporation
Connect
WITH RESPECT TO SPECIFICATION
FCC 47CFR 15D

TEST DATE: 11th May – 19th November 2020

Written by:	D Winstanley	D Winstanley
Tested by:	D Winstanley	D Winstanley, S Garwell Radio Test Engineers
Approved by:	 Digitally signed by John Charters DN: cn=John Charters, o, ou=Element Materials Technology Ltd., email=john.charters@element.com, c=GB Reason: I am approving this document Date: 2020.11.20 14:59:39 Z	J Charters Department manager - Radio
Date:	20th November 2020	

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Registered in England and Wales. Registered Office: 5 Fleet Place, London, EC4M 7RD
Company Reg No. 02536659

1 Revision Record

Issue Number	*Issue Date*	*Revision History*
A	2020-07-11	Original
B	2020-11-19	Added test results for DECT_BTC AC Powerline

2 Summary

TEST REPORT NUMBER:	TRA-049218-47-02B
WORKS ORDER NUMBER:	TRA-046687-01
PURPOSE OF TEST:	USA: Testing of radio frequency equipment per the relevant authorization procedure of chapter 47 of CFR (code of federal regulations) Part 2, subpart J.
TEST SPECIFICATION(S):	FCC 47CFR 15D
EQUIPMENT UNDER TEST (EUT):	Connect
FCC IDENTIFIER:	V9N950140600V1
MANUFACTURER/AGENT:	Sonetics Corporation
ADDRESS:	17600 SW 65th Ave Lake Oswego OR 97035 USA
CLIENT CONTACT:	Marcie Dobyns ☎ 0800 833 4558 ✉ Marcie.Dobyns@Soneticscorp.com
TEST DATE:	11th May – 19th November 2020
TESTED BY:	D Winstanley, S Garwell Element

2.1 Test Summary

TEST/EXAMINATION	Part 15	Result
Coordination with Fixed Microwave Service	15.307 (b)	No Note 1
Antenna Requirement	15.317 15.203	Pass
Modulation Techniques	15.319 (b)	Pass
Conducted AC Powerline	15.315 15.207	No Note 2
Emission Bandwidth	15.323 (a)	Pass
Peak Transmit Power	15.319 (c)	Pass
Power Spectral Density	15.319 (d)	Pass
Antenna Gain	15.319 (e)	Pass
Automatic Discontinuation of Transmission	15.319 (f)	Pass
Radio Frequency Radiation Exposure	15.319 (i)	Pass
Monitoring Thresholds	15.323 (c)(2) 15.323 (c)(9)	Pass
Monitoring of Intended Transmit Window and Maximum Reaction Time	15.323 (c)(1)	Pass
Monitoring Bandwidth	15.323 (c)(7)	Pass
Access Criteria Functional Test	15.323 (c)(6)	Note 3
Duration of Transmission	15.323 (c)(3)	Pass
Connection Acknowledgement	15.323 (c)(4)	Pass
Lower threshold Selected Channel, Power Accuracy, Segment Occupancy	15.323 (c)(5)	Pass
Monitoring Antenna	15.323 (c)(8)	Pass
Duplex Connections	15.323 (c)(10)	Pass
Alternative Monitoring Interval for Co-located Devices	15.323 (c)(11)	Note 4
Fair Access to Spectrum Related to (c)(10) & (c)(11)	15.323 (c)(12)	Note 4
Emission Inside and Outside the Sub-band	15.323 (d)	Pass
Frame Period	15.323 (e)	Pass
Frequency Stability	15.323 (f)	Pass

Note: 1. Requirement removed April 4th 2005 see public notice DX 05-1005.
2. The portable part is battery powered.
3. The EUT does not transmit control and signalling information.
4. The EUT does not utilise the provisions of 15.323 (c)(11)

Notes:

The results contained in this report relate only to the items tested, in the condition at time of test, and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.

The apparatus was set up and exercised using the configurations, modes of operation and arrangements defined in this report only. Any modifications made are identified in Section 8 of this report.

Particular operating modes, apparatus monitoring methods and performance criteria required by the standards tested to have been performed except where identified in Section 5.2 of this test report (Deviations from Test Standards).

3 Contents

4 Introduction

This report TRA-049218-47-02B presents the results of the Radio testing on a Sonetics Corporation, Connect to specification 47CFR15 Radio Frequency Devices.

The testing was carried out for Sonetics Corporation by Element, at the addresses detailed below.

☐ Element Hull
Unit E
South Orbital Trading Park
Hedon Road
Hull
HU9 1NJ
UK

☒ Element Skelmersdale
Unit 1
Pendle Place
Skelmersdale
West Lancashire
WN8 9PN
UK

This report details the configuration of the equipment, the test methods used and any relevant modifications where appropriate.

All test and measurement equipment under the control of the laboratory and requiring calibration is subject to an established programme and procedures to control and maintain measurement standards. The quality management system meets the principles of ISO 9001, and has quality control procedures for monitoring the validity of tests undertaken. Records and sufficient detail are retained to establish an audit trail of calibration records relating to its test results for a defined period. Under control of the established calibration programme, key quantities or values of the test & measurement instrumentation are within specification and comply with the relevant traceable internationally recognised and appropriate standard specifications, which are UKAS calibrated as such where these properties have a significant effect on results. Participation in inter-laboratory comparisons and proficiency testing ensures satisfactory correlation of results conform to Elements own procedures, as well as statistical techniques for analysis of test data providing the appropriate confidence in measurements.

FCC Site Listing:
Element is accredited for the above sites under the US-EU MRA, Designation number UK0009.

ISED Registration Number(s):

Element Skelmersdale	3930B
Element Hull	3483A

The test site requirements of ANSI C63.4-2014 are met up to 1 GHz.

The test site SVSWR requirements of CISPR 16-1-4:2010 are met over the frequency range 1 GHz to 18 GHz.

5 Test Specifications

5.1 Normative References

- FCC 47 CFR Ch. I – Part 15 – Radio Frequency Devices.
- ANSI C63.10-2013 – American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.
- ANSI C63.4-2014 – American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
- ANSI C63.17-2013 - American National Standard Methods of Measurement of the Electromagnetic and Operational Compatibility of Unlicensed Personal Communications Services (UPCS) Devices
- Industry Canada RSS-213, Issue 3, March 2015 – 2 GHz Licence-Exempt Personal Communications Services (LE-PCS) Devices.
- Industry Canada RSS-Gen, Issue 5, March 2019 – General Requirements for Compliance of Radio Apparatus

5.2 Deviations from Test Standards

There were no deviations from the test standard.

6 Glossary of Terms

§	denotes a section reference from the standard, not this document
AC	Alternating Current
ANSI	American National Standards Institute
BW	bandwidth
C	Celsius
CFR	Code of Federal Regulations
CW	Continuous Wave
dB	decibel
dBm	dB relative to 1 milliwatt
DC	Direct Current
DSSS	Direct Sequence Spread Spectrum
EIRP	Equivalent Isotropically Radiated Power
ERP	Effective Radiated Power
EUT	Equipment Under Test
FCC	Federal Communications Commission
FHSS	Frequency Hopping Spread Spectrum
Hz	hertz
IC	Industry Canada (now ISED)
ISED	Innovation, Science and Economic Development Canada
ITU	International Telecommunication Union
LBT	Listen Before Talk
m	metre
max	maximum
MIMO	Multiple Input and Multiple Output
min	minimum
MRA	Mutual Recognition Agreement
N/A	Not Applicable
PCB	Printed Circuit Board
PDF	Portable Document Format
Pt-mpt	Point-to-multipoint
Pt-pt	Point-to-point
RF	Radio Frequency
RH	Relative Humidity
RMS	Root Mean Square
Rx	receiver
s	second
SVSWR	Site Voltage Standing Wave Ratio
Tx	transmitter
UKAS	United Kingdom Accreditation Service
V	volt
W	watt
Ω	ohm

7 Equipment Under Test

7.1 EUT Identification

- Name: Connect
- Model Number: APX-Connect
- Serial Number: Not Stated
- Software Revision: bpp_BETA1_0324_b14
- Build Level / Revision Number: Rev 14

7.2 System Equipment

Equipment listed below forms part of the overall test setup and is required for equipment functionality and/or monitoring during testing. The compliance levels achieved in this report relate only to the EUT and not items given in the following list.

The following Element support equipment was used

Type – Digital Radiocommunication Tester
Model – CMD60
Reference number – RFG433

The following support equipment was provided by the manufacturer

Type – Wireless Base Station
Model – SON150

Type – USB to Serial Adaptor

7.3 EUT Mode of Operation

7.3.1 Transmission

The mode of operation for transmitter tests was as follows…

The EUT was set into transmit mode via a serial interface. A command sequence was used to set the unit transmitting on the required antenna and frequency.

For limited testing the device was also connected to a CMD60 test set

For AC powerline conduction testing the Bluetooth LE was also set into a permanent transit test mode.

For AC powerline conduction testing the Bluetooth Classic was also set into a permanent transit test mode.

7.4 EUT Radio Parameters

7.4.1 General

Band of operation:	1920 MHz – 1930 MHz
Frequency range of operation:	1921.536 MHz – 1928.448 MHz
Modulation type(s):	GFSK
Occupied channel bandwidth(s):	1.43 MHz
Channel spacing:	1.728 MHz
ITU emission designator(s):	F1D
Declared output power(s):	<112 mW
Warning against use of alternative antennas in user manual (yes/no):	Not Applicable
Nominal Supply Voltage:	3.8 Vdc
Location of notice for license exempt use:	Label / user manual / both.
Duty cycle:	8.3 %

7.4.2 Antennas

Type:	Integral
Frequency range:	1920 MHz – 1930 MHz
Impedance:	50 Ohms
Gain:	3.94 dBi
Polarisation:	Omni

7.5 EUT Description

The EUT is a UPCS Headset the headset also utilises Bluetooth. This report covers the UPCS device operation.

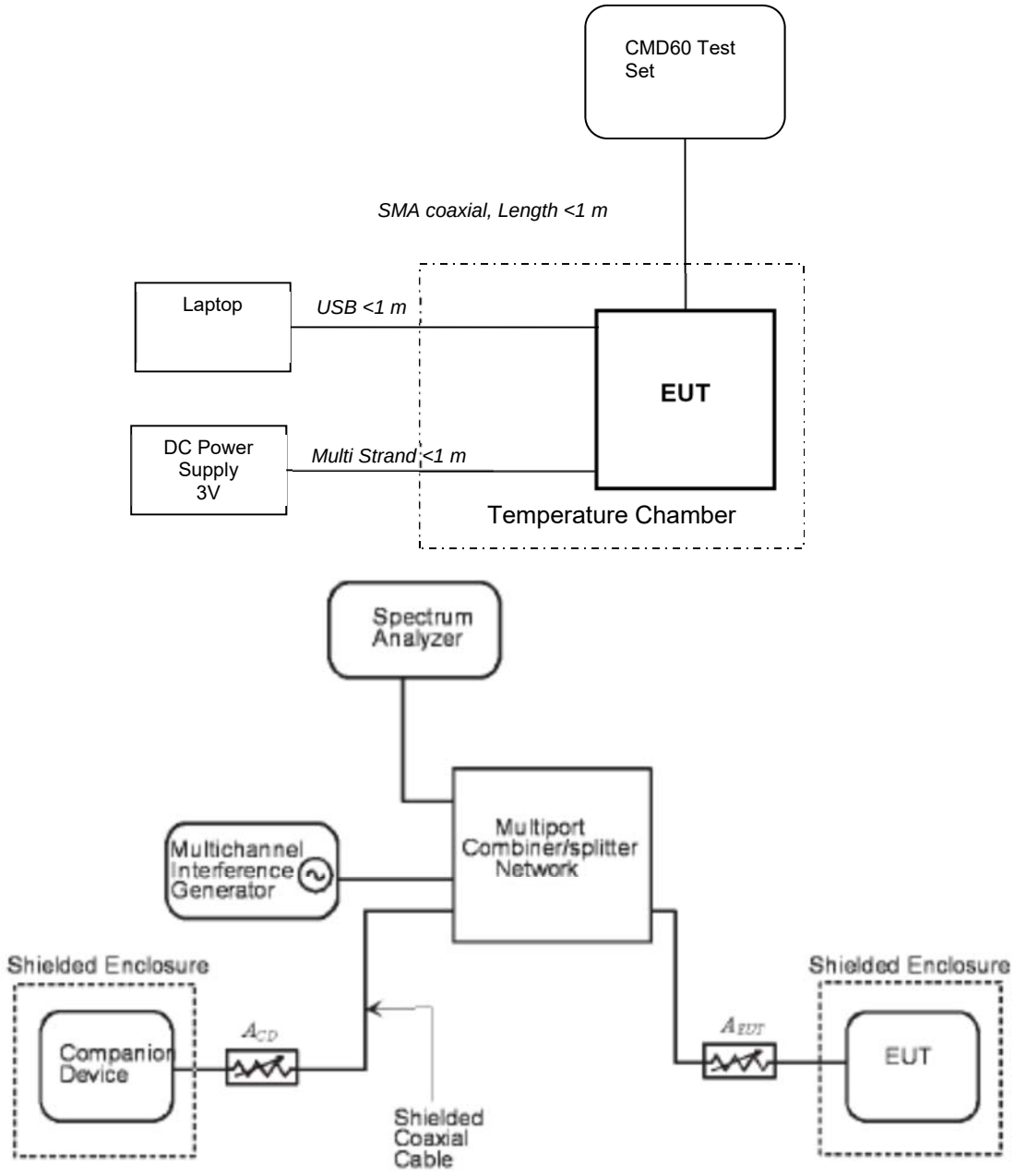
8 Modifications

No modifications were performed during this assessment.

9 EUT Test Setup

9.1 Block Diagram

The following diagram shows basic EUT interconnections with cable type and cable lengths identified:



10 General Technical Parameters

10.1 Normal Conditions

The E U T was tested under the normal environmental conditions of the test laboratory, except where otherwise stated. The normal power source applied was 3.6 V dc from internal battery.

10.2 Varying Test Conditions

Variation of temperature is required to ensure stability of the declared fundamental frequency. During frequency error testing the following variations were made:

	Category	***Variation***
☒	Standard	-20 to +50 C
☐	Extended	

Variation of supply voltage is required to ensure stability of the declared output power and frequency. During carrier power and frequency error testing the following variations were made:

	Category	***Nominal***	***Variation***
☐	Mains	110 V ac +/-2 %	85 % and 115 %
☒	Battery	New battery	Not Applicable

11 Antenna Requirements

11.1 Definition

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device

11.2 Test Limit

The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section.

11.3 Test Result (Attestation)

The unit employs an integral antenna arrangement.

12 Modulation Techniques

12.1 Definition

All transmissions must use only digital modulation techniques.

12.2 Test Limit

Attestation of compliance with the digital modulation requirement will be made in accordance with the disclosure statement required by the applicable equipment authorization procedures (see, e.g., 47CFR2).

12.3 Test Result (Attestation)

The Sonetics Corporation Connect is an isochronous device operating in the 1920 MHz – 1930 MHz frequency band.

The Sonetics Corporation Connect modulation technique is based on DECT technology as described in European standards EN 300 175-2 and EN 300 175-3.

The Sonetics Corporation Connect modulation techniques are MC/TDMA/TDD (Multi Carrier / Time Division Multiple Access / Time Division Duplex) using GFSK modulation.

13 AC power-line conducted emissions (BLE)

13.1 Definition

Line-to-ground radio-noise voltage that is conducted from all of the EUT current-carrying power input terminals that are directly (or indirectly via separate transformers or power supplies) connected to a public power network.

13.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	LF Laboratory
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.2
EUT Channels / Frequencies Measured:	DECT – Mid; BLE – Mid
EUT Channel Bandwidths:	1.4 MHz
EUT Modulation:	GFSK
Deviations From Standard:	None
Measurement Detectors:	Quasi-Peak and; Average, RMS

Environmental Conditions (Normal Environment)

Temperature: 20 °C	+15 ºC to +35 ºC (as declared)
Humidity: 45 % RH	20 % RH to 75 % RH (as declared)
Supply: 120 Vac	To Mains adaptor

13.3 Test Limit

A radio apparatus that is designed to be connected to the public utility (AC) power line shall ensure that the radio frequency voltage, which is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz, shall not exceed the limits in Table 3.

Table 3 – AC Power Line Conducted Emission Limits

Frequency (MHz)	***Conducted limit (dBµV)***	
	Quasi-Peak	***Average****
0.15 to 0.5	66 to 56*	56 to 46*
0.5 to 5	56	46
5 to 30	60	50

*The level decreases linearly with the logarithm of the frequency.
**A linear average detector is required.

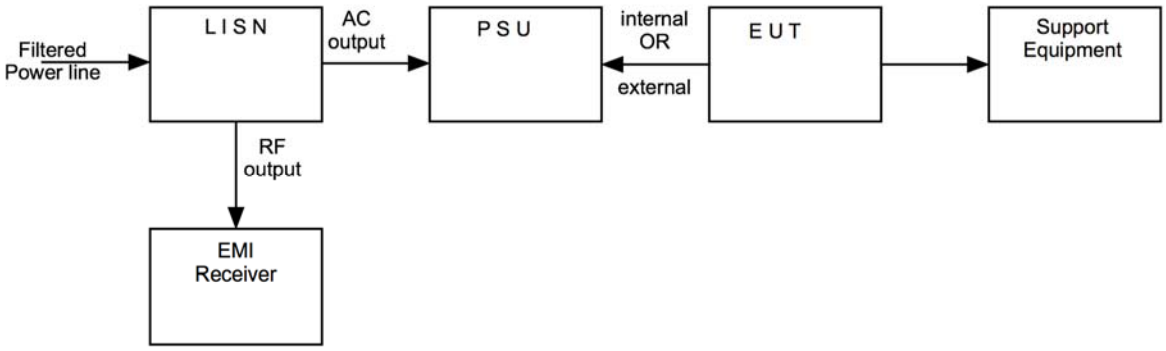
13.4 Test Method

With the EUT setup in a screened room, as per section 9 of this report and connected as per Figure ii, the power line emissions were measured on a spectrum analyzer / EMI receiver.

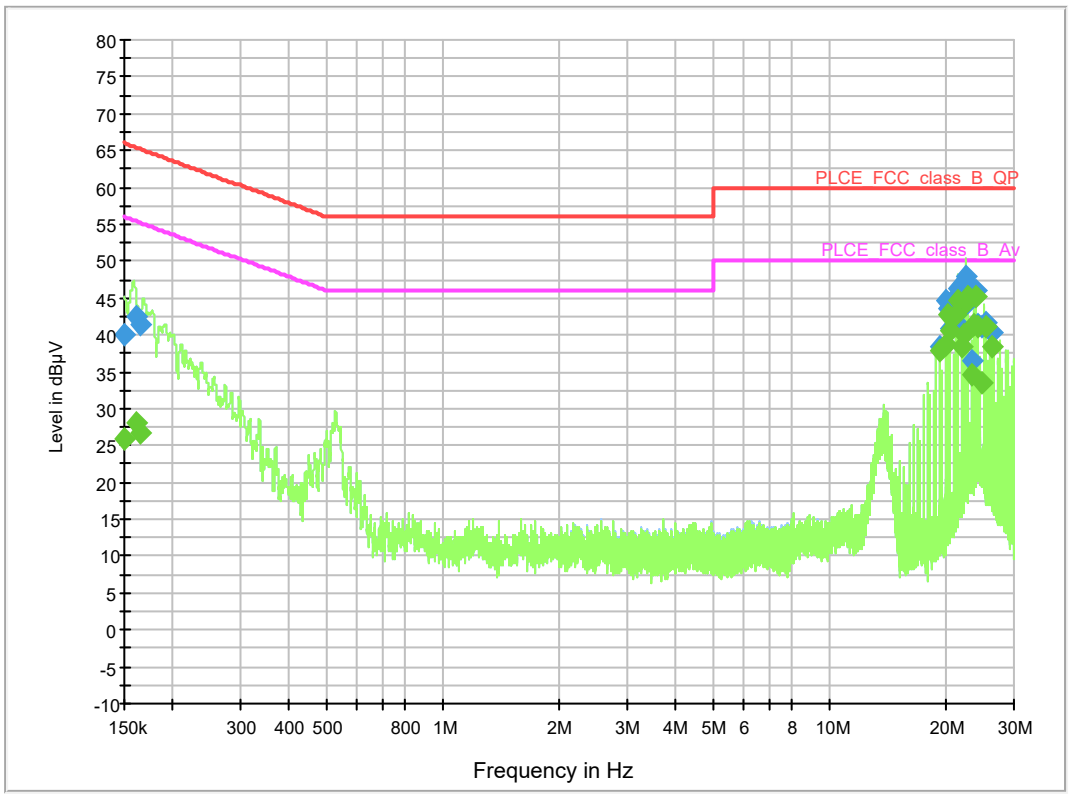
AC power line conducted emissions from the EUT are checked first by preview scans with peak and average detectors covering both live and neutral lines. A spectrum analyzer is used to determine if any periodic emissions are present.

Formal measurements using the correct detector(s) and bandwidth are made on frequencies identified from the preview scans. Final measurements were performed with EUT set at its maximum duty in transmit and receive modes.

Figure ii Test Setup



13.5 Test Results



The above plot is generated from combined live and neutral max hold Peak and Average detector preview scans. The blue markers are maximised Quasi-Peak detectors. The green markers are maximised Average detectors. Both are required for the formal assessment. The above emissions are listed in the following tables.

The above plot shows a number of formal measurements that are significantly below the preview peak hold. These emissions were manually investigated for a minimum time period of 60seconds. During this time period the emissions were found to occur at a time interval of less than once in a 15 second period and therefore considered transient in nature as per the guidelines in CISPR16-2-3 and are deemed a pass result.

Quasi Peak Detector								
Frequency (MHz)	**QuasiPeak (dBµV)**	**Meas. Time (ms)**	**Bandwidth (kHz)**	**Filter**	**Line**	**Corr. (dB)**	**Margin (dB)**	**Limit (dBµV)**
0.195000	31.7	2000.0	10.000	On	L1	19.4	32.2	63.8
0.360000	26.6	2000.0	10.000	On	L1	19.5	32.2	58.7
0.555000	36.5	2000.0	10.000	On	N	19.4	19.5	56.0
0.580000	35.4	2000.0	10.000	On	L1	19.5	20.6	56.0
0.620000	25.9	2000.0	10.000	On	N	19.5	30.1	56.0
0.685000	26.2	2000.0	10.000	On	L1	19.5	29.8	56.0
0.790000	27.2	2000.0	10.000	On	N	19.5	28.8	56.0
1.075000	28.9	2000.0	10.000	On	N	19.5	27.1	56.0
1.195000	28.1	2000.0	10.000	On	N	19.5	27.9	56.0
1.230000	29.0	2000.0	10.000	On	N	19.5	27.0	56.0
1.620000	28.1	2000.0	10.000	On	N	19.5	27.9	56.0
1.815000	27.8	2000.0	10.000	On	N	19.5	28.2	56.0
2.170000	23.3	2000.0	10.000	On	N	19.5	32.7	56.0
3.505000	21.3	2000.0	10.000	On	N	19.5	34.7	56.0
8.025000	26.8	2000.0	10.000	On	N	19.6	33.2	60.0

Average Detector								
Frequency (MHz)	**Average (dBµV**	**Meas. Time (ms)**	**Bandwidth (kHz)**	**Filter**	**Line**	**Corr. (dB)**	**Margin (dB)**	**Limit (dBµV)**
0.460000	19.8	2000.0	10.000	On	N	19.4	26.9	46.7
0.555000	26.0	2000.0	10.000	On	N	19.4	20.0	46.0
0.585000	33.0	2000.0	10.000	On	N	19.5	13.0	46.0
0.615000	23.8	2000.0	10.000	On	N	19.5	22.2	46.0
0.675000	16.7	2000.0	10.000	On	N	19.5	29.3	46.0
0.955000	18.4	2000.0	10.000	On	N	19.5	27.6	46.0
0.985000	20.1	2000.0	10.000	On	N	19.5	25.9	46.0
1.170000	16.9	2000.0	10.000	On	N	19.5	29.1	46.0
1.200000	20.7	2000.0	10.000	On	N	19.5	25.3	46.0
1.230000	18.7	2000.0	10.000	On	N	19.5	27.3	46.0
1.260000	18.8	2000.0	10.000	On	N	19.5	27.2	46.0
1.750000	12.7	2000.0	10.000	On	N	19.5	33.3	46.0
1.780000	15.4	2000.0	10.000	On	N	19.5	30.6	46.0
1.815000	19.7	2000.0	10.000	On	N	19.5	26.3	46.0
1.845000	18.0	2000.0	10.000	On	N	19.5	28.0	46.0

14 AC power-line conducted emissions (BTC)

14.1 Definition

Line-to-ground radio-noise voltage that is conducted from all of the EUT current-carrying power input terminals that are directly (or indirectly via separate transformers or power supplies) connected to a public power network.

14.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Transient Laboratory
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.2
EUT Channels / Frequencies Measured:	DECT – Mid; BTC – Mid
EUT Channel Bandwidths:	1.4 MHz
EUT Modulation:	GFSK
Deviations From Standard:	None
Measurement Detectors:	Quasi-Peak and; Average, RMS

Environmental Conditions (Normal Environment)

Temperature: 20 °C	+15 ºC to +35 ºC (as declared)
Humidity: 45 % RH	20 % RH to 75 % RH (as declared)
Supply: 120 Vac	To Mains adaptor

14.3 Test Limit

A radio apparatus that is designed to be connected to the public utility (AC) power line shall ensure that the radio frequency voltage, which is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz, shall not exceed the limits in Table 3.

Table 3 – AC Power Line Conducted Emission Limits

Frequency (MHz)	***Conducted limit (dBµV)***	
	Quasi-Peak	***Average****
0.15 to 0.5	66 to 56*	56 to 46*
0.5 to 5	56	46
5 to 30	60	50

*The level decreases linearly with the logarithm of the frequency.
**A linear average detector is required.

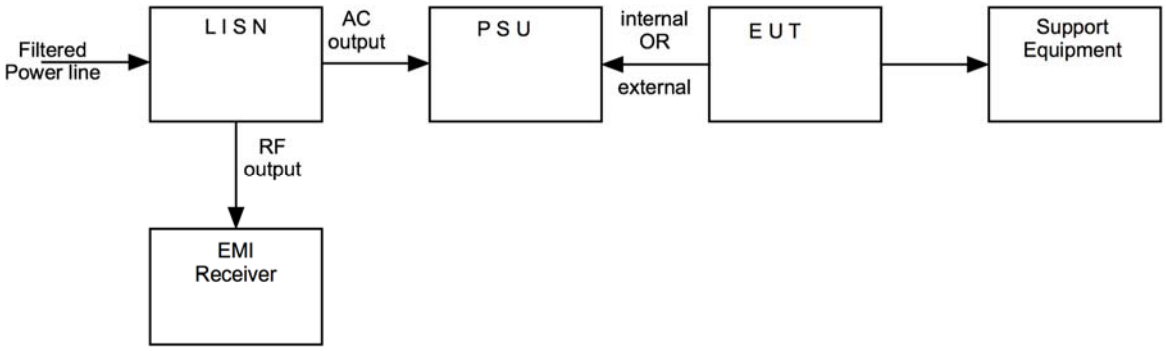
14.4 Test Method

With the EUT setup in a screened room, as per section 9 of this report and connected as per Figure ii, the power line emissions were measured on a spectrum analyzer / EMI receiver.

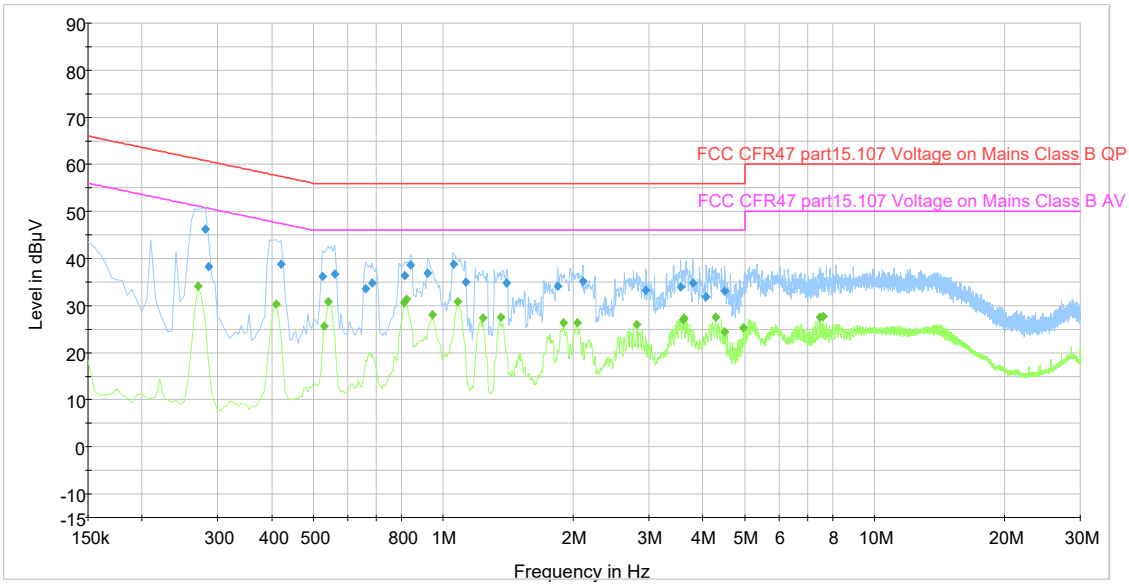
AC power line conducted emissions from the EUT are checked first by preview scans with peak and average detectors covering both live and neutral lines. A spectrum analyzer is used to determine if any periodic emissions are present.

Formal measurements using the correct detector(s) and bandwidth are made on frequencies identified from the preview scans. Final measurements were performed with EUT set at its maximum duty in transmit and receive modes.

Figure ii Test Setup



14.5 Test Results



The above plot is generated from combined live and neutral max hold Peak and Average detector preview scans. The blue markers are maximised Quasi-Peak detectors. The green markers are maximised Average detectors. Both are required for the formal assessment. The above emissions are listed in the following tables.

The above plot shows a number of formal measurements that are significantly below the preview peak hold. These emissions were manually investigated for a minimum time period of 60seconds. During this time period the emissions were found to occur at a time interval of less than once in a 15 second period and therefore considered transient in nature as per the guidelines in CISPR16-2-3 and are deemed a pass result.

Quasi Peak Detector								
Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.280000	46.2	2000.0	10.000	On	N	19.5	14.6	60.8
0.285000	38.3	2000.0	10.000	On	N	19.5	22.3	60.7
0.420000	38.8	2000.0	10.000	On	N	19.5	18.7	57.4
0.525000	36.1	2000.0	10.000	On	L1	19.5	19.9	56.0
0.560000	36.7	2000.0	10.000	On	N	19.5	19.3	56.0
0.660000	33.5	2000.0	10.000	On	N	19.5	22.5	56.0
0.685000	34.9	2000.0	10.000	On	N	19.5	21.1	56.0
0.815000	36.5	2000.0	10.000	On	L1	19.5	19.5	56.0
0.840000	38.6	2000.0	10.000	On	L1	19.5	17.4	56.0
0.920000	36.8	2000.0	10.000	On	L1	19.5	19.2	56.0
1.055000	38.9	2000.0	10.000	On	L1	19.5	17.1	56.0
1.125000	35.0	2000.0	10.000	On	L1	19.5	21.0	56.0
1.400000	34.7	2000.0	10.000	On	L1	19.5	21.3	56.0
1.840000	34.1	2000.0	10.000	On	L1	19.5	21.9	56.0
2.105000	35.2	2000.0	10.000	On	L1	19.6	20.8	56.0
2.950000	33.2	2000.0	10.000	On	L1	19.6	22.8	56.0
3.550000	34.0	2000.0	10.000	On	L1	19.6	22.0	56.0
3.790000	34.8	2000.0	10.000	On	L1	19.6	21.2	56.0
4.070000	31.8	2000.0	10.000	On	L1	19.6	24.2	56.0
4.490000	33.1	2000.0	10.000	On	L1	19.7	22.9	56.0

Average Detector								
Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.270000	34.1	2000.0	10.000	On	L1	19.5	17.0	51.1
0.410000	30.4	2000.0	10.000	On	L1	19.5	17.3	47.6
0.530000	25.7	2000.0	10.000	On	L1	19.5	20.3	46.0
0.540000	30.9	2000.0	10.000	On	L1	19.5	15.1	46.0
0.810000	30.7	2000.0	10.000	On	L1	19.5	15.3	46.0
0.820000	31.4	2000.0	10.000	On	L1	19.5	14.6	46.0
0.945000	28.0	2000.0	10.000	On	L1	19.5	18.0	46.0
1.080000	30.8	2000.0	10.000	On	L1	19.5	15.2	46.0
1.235000	27.3	2000.0	10.000	On	L1	19.5	18.7	46.0
1.360000	27.6	2000.0	10.000	On	L1	19.5	18.4	46.0
1.900000	26.3	2000.0	10.000	On	L1	19.6	19.7	46.0
2.040000	26.3	2000.0	10.000	On	L1	19.6	19.7	46.0
2.810000	26.0	2000.0	10.000	On	L1	19.6	20.0	46.0
3.590000	27.0	2000.0	10.000	On	L1	19.6	19.0	46.0
3.615000	27.4	2000.0	10.000	On	L1	19.6	18.6	46.0
4.280000	27.5	2000.0	10.000	On	L1	19.6	18.5	46.0
4.495000	24.5	2000.0	10.000	On	L1	19.7	21.5	46.0
4.960000	25.3	2000.0	10.000	On	L1	19.7	20.7	46.0
7.450000	27.5	2000.0	10.000	On	L1	19.7	22.5	50.0
7.585000	27.8	2000.0	10.000	On	L1	19.7	22.2	50.0

15 Radio Frequency Radiation Exposure

This requirement is covered under an alternative report.

16 Transmitter Emission Bandwidth

16.1 Definition

The emission bandwidth (x dB) is defined as the frequency range between two points, one above and one below the carrier frequency, at which the spectral density of the emission is attenuated x dB below the maximum in-band spectral density of the modulated signal.

16.2 Test Parameters

Measurement standard	ANSI C63.17 sub-clause 6.1.3
Test Location:	Element Skelmersdale
Test Chamber:	Radio Laboratory
Measurement BW:	20 kHz
Spectrum Analyzer Video BW:	200 kHz
Measurement Span:	3 MHz
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 22 °C	+15 ºC to +35 ºC (as declared)
Humidity: 42 % RH	20 % RH to 75 % RH (as declared)

16.3 Test Limit

Operation shall be contained within the 1920 MHz to 1930 MHz band. The emission bandwidth shall be less than 2.5 MHz but in no event shall the emission bandwidth be less than 50 kHz.

The emission bandwidth shall be determined by measuring the width of the signal between two points, one below the carrier centre frequency and one above the carrier centre frequency, that are 26 dB own relative to the maximum level of the modulated carrier.

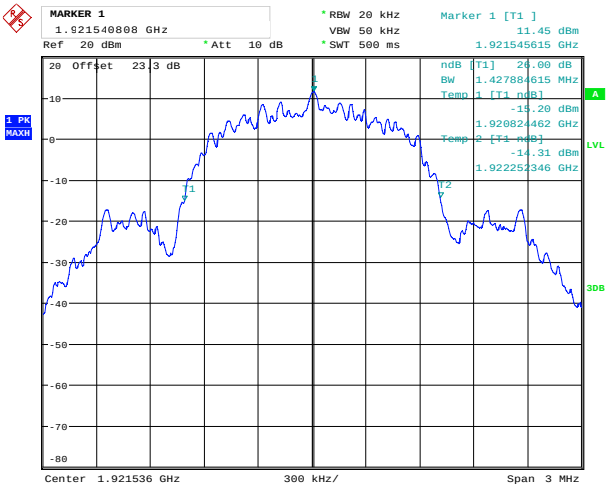
16.4 Test Results

Test Details: f_l = 1921.536 MHz				
∆ P (dBc)	fl (MHz)	fh (MHz)	∆f (MHz)	Limit
-26	1920.824462	1922.252346	1.428	50kHz<∆f<2.5MHz
-12	1920.947538	1922.140808	1.193	N/A
-6	1921.239846	1921.840808	0.601	N/A

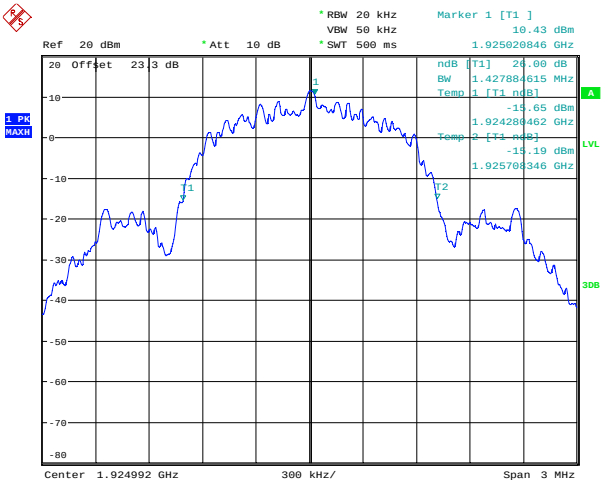
Test Details: f_c = 1924.992 MHz				
∆ P (dBc)	fl (MHz)	fh (MHz)	∆f (MHz)	Limit
-26	1924.280462	1925.708346	1.428	50kHz<∆f<2.5MHz
-12	1924.408346	1925.598846	1.191	N/A
-6	1924.600654	1925.294038	0.693	N/A

Test Details: f_h = 1928.448 MHz				
∆ P (dBc)	fl (MHz)	fh (MHz)	∆f (MHz)	Limit
-26	1927.736462	1929.159538	1.423	50kHz<∆f<2.5MHz
-12	1927.859538	1929.049923	1.190	N/A
-6	1928.056654	1928.751846	0.695	N/A

26 dB Emission Bandwidth



f_l



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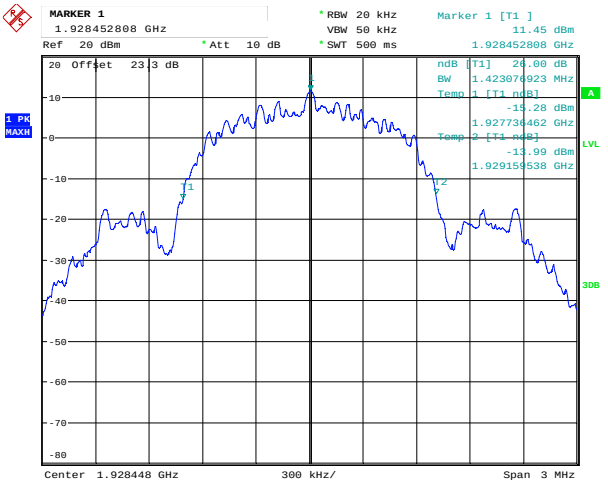


f_h

17 Peak Transmit Power

17.1 Definition

The peak transmit power is the maximum of the RMS power during a transmit burst

17.2 Test Parameters

Measurement standard	ANSI C63.17 sub-clause 6.1.2
Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
EUT Channels / Frequencies Measured:	Low / Mid / High
EUT Occupied Bandwidths:	1.36 MHz
Measurement BW:	3 MHz
Measurement Span:	Zero Span
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 22 °C	+15 ºC to +35 ºC (as declared)
Humidity: 42 % RH	20 % RH to 75 % RH (as declared)

17.3 Test Limit

Peak transmit power shall not exceed 100 μW multiplied by the square root of the emission bandwidth in hertz

The limit for Peak Transmit Power (PTP) is calculated using the following formula:

$$PTP = 5 \text{ Log}_{10} \text{ EBW} – 10 - (G_A – g)\text{dBm}$$

This limit must be corrected to take into account the EUT transmit antenna maximum gain (G_A) over the allowable excess gain over that of an isotropic antenna without a transmit power reduction (g)
Where: EBW is the transmitter emission bandwidth in Hz as determined in the previous test.

EBW =	1.36MHz
G_A =	3.94 dBi
G =	3

$$PTP = 5 \text{ Log}_{10} \text{ } 1.36 – 10 - (3.94 – 3) \text{ dBm}$$

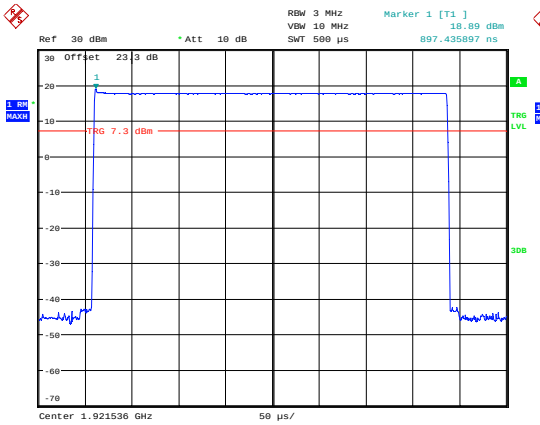
$$PTP = 20.77 – 0.94 \text{ dBm}$$

$$PTP = 19.83 \text{ dBm}$$

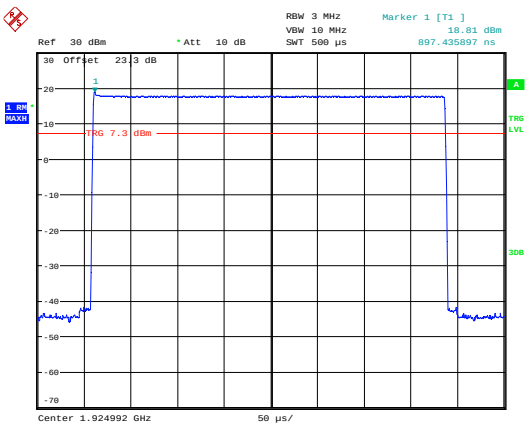
17.4 Test Results

Frequency (MHz)	Peak Transmit Power (dBm)	Limit (dBm)
1921.536	18.89	19.83
1924.992	18.81	19.83
1928.448	18.72	19.83

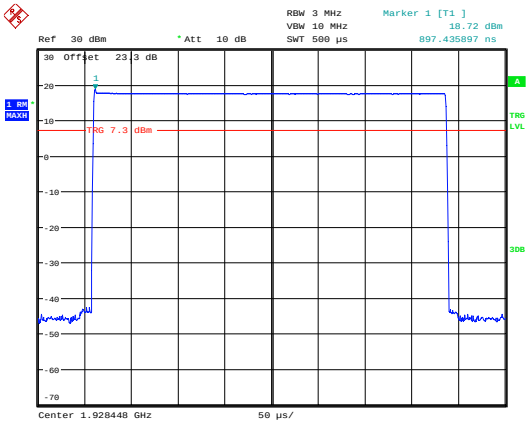
Note: 1. Permanent antenna was replaced with temporary antenna connector to enable conducted measurement.



f_l



f_c



f_h

18 Power Spectral Density

18.1 Definition

The power per unit bandwidth.

18.2 Test Parameters

Measurement standard	ANSI C63.17 sub-clause 6.1.5
Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
EUT Channels / Frequencies Measured:	Low / Mid / High
EUT Occupied Bandwidths:	1.36 MHz
Measurement BW:	3 kHz
Measurement Span:	Zero Span
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

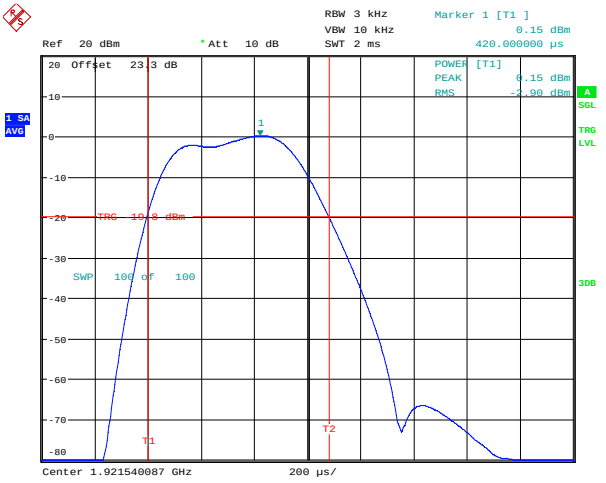
Temperature: 22 °C	+15 ºC to +35 ºC (as declared)
Humidity: 42 % RH	20 % RH to 75 % RH (as declared)

18.3 Test Limit

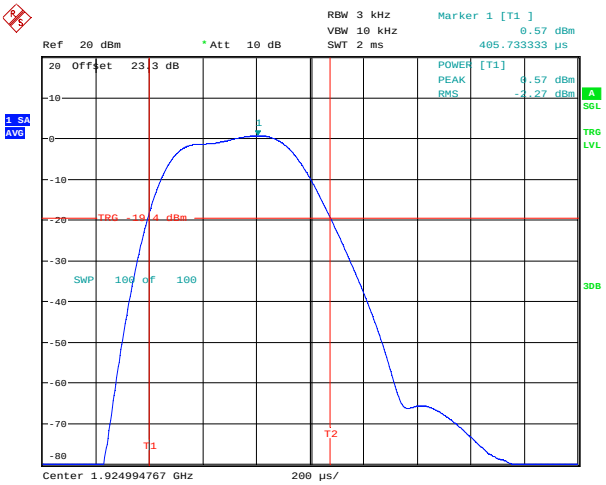
The power spectral density shall not exceed 3mW in any 3 kHz bandwidth as measured with a spectrum analyser having a resolution bandwidth of 3 kHz.

Frequency (MHz)	Power Spectral Density (mW/3kHz)	Limit (mW/3kHz)
1921.536	0.51	3
1924.992	0.59	3
1928.448	0.52	3

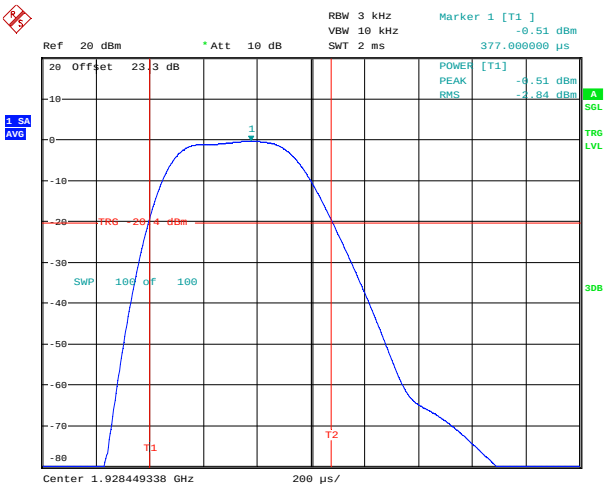
Note: 1. Permanent antenna was replaced with temporary antenna connector to enable conducted measurement.


RBW 3 kHz
VBW 10 kHz
SWT 2 ms
Marker 1 [T1]
0.15 dBm
420.000000 µs
Ref 20 dBm
*Att 10 dB
20 Offset 23.3 dB
POWER [T1]
PEAK 0.15 dBm
RMS -2.90 dBm
1 SA
AVG
A
SGL
TRG
LVL
TRG -19.8 dBm
SWP 100 of 100
3DB
T1
T2
Center 1.921540087 GHz
200 µs/

f_l


RBW 3 kHz
VBW 10 kHz
SWT 2 ms
Marker 1 [T1]
0.57 dBm
405.733333 µs
Ref 20 dBm
*Att 10 dB
20 Offset 23.3 dB
POWER [T1]
PEAK 0.57 dBm
RMS -2.27 dBm
1 SA
AVG
A
SGL
TRG
LVL
TRG -19.4 dBm
SWP 100 of 100
3DB
T1
T2
Center 1.924994767 GHz
200 µs/

f_c


RBW 3 kHz
VBW 10 kHz
SWT 2 ms
Marker 1 [T1]
-0.51 dBm
377.000000 µs
Ref 20 dBm
*Att 10 dB
20 Offset 23.3 dB
POWER [T1]
PEAK -0.51 dBm
RMS -2.84 dBm
1 SA
AVG
A
SGL
TRG
LVL
TRG -20.4 dBm
SWP 100 of 100
3DB
T1
T2
Center 1.928449338 GHz
200 µs/

f_h

19 Antenna Gain

19.1 Definition

Any directional gain of the antenna exceeding 3 dBi has an effect on the limit applied to the measurements taken for the peak transmit power test. If the directional gain of the antenna is less than 3dBi it is not required to be taken into account.

19.2 Test Limit

The peak transmit power shall be reduced by the amount in decibels that the maximum directional gain of the antenna exceeds 3 dBi.

19.3 Test Result (Attestation)

Maximum Antenna Gain	Exceeds 3 dBi by
3.91 dBi	0.91 dBi

Antenna Gain declared by Manufacturer

20 Automatic Discontinuation of Transmissions

20.1 Definition

Automatic discontinuation of transmission means break off of transmissions that are not control and signalling information.

20.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
EUT Channels / Frequencies Measured:	Mid

Environmental Conditions (Normal Environment)

Temperature: 22 °C	+15 ºC to +35 ºC (as declared)
Humidity: 42 % RH	20 % RH to 75 % RH (as declared)

20.3 Test Limit

The device shall automatically discontinue transmission in case of either absence of information to transmit or operational failure. These provisions are not intended to preclude transmission of control and signalling information or use of repetitive codes used by certain digital technologies to complete frame or burst intervals.

20.4 Test Results

The EUT is a Portable part and as such does not transmit control and signalling information the counterpart device is a fixed part device and does transmit control and signalling information.

Part	Transmits Control and Signalling Information	Equipment Under Test
Fixed Part	X	
Portable Part		X

The following tests were performed after a connection had been established with the counterpart device

Number	Test	Reaction of EUT	Pass / Fail
1	EUT manually powered down	C	Pass
2	EUT battery flat / removed	C	Pass
3	Power removed from Companion	A	Pass

A – Connection breakdown, Cease of all transmissions.
B – Connection breakdown, EUT transmits control and signalling information.
C – Connection breakdown, Counterpart transmits control and signalling information.

21 Monitoring Thresholds

21.1 Definition

The spectrum sharing rules require that EUTs monitor their intended channel (time and spectrum window) prior to transmission to sense RF energy in the channel. If there is RF energy above the monitoring limit threshold the EUT must either defer transmission until the channel is clear or select another clear channel.

21.2 Test Parameters

Measurement standard - Calculation	ANSI C63.17 sub-clause 7.2.1
Calculations	As laid out in ANSI C63.17 sub-clause 4.3.3
Measurement standard	ANSI C63.17 sub-clause 7.3
Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab

21.3 Calculations

Calculation of monitoring threshold limits for isochronous devices:

Lower threshold: $T_L = -174 + 10Log_{10}B + M_U + P_{MAX} - P_{EUT}$ (dBm)

Upper threshold: $T_U = -174 + 10Log_{10}B + M_U + P_{MAX} - P_{EUT}$ (dBm)

Where:
B = Emission bandwidth (Hz)
M_U = dBs the threshold may exceed thermal noise (30 for T_L & 50 for T_U)
P_{MAX} = Output Power Limit (dBm)
P_{EUT} = Transmitted power (dBm)

Monitor Threshold	B (Hz)	M_U (dB)	P_{MAX} (dBm)	P_{EUT} (dBm)	Threshold (dBm)
T_L	1358975.00	30.00	20.67	18.13	-80.13
T_U	1358975.00	50.00	20.67	18.13	-60.13

Note: 1. Threshold levels rounded up/down

The threshold level was determined following the procedure as laid out in ANSI C63.17 sub-clause 7.3.1 (a) Frequency administration was used to allow operation on the carrier closest to the centre of the band.

21.4 Test Limit

The EUT must not transmit until the interference level is less than or equal to:

Measured Threshold Level ≤ $T_L + U_M$

Where:
T_U = Calculated Upper threshold level
T_L = Calculated Lower threshold level
U_M = Margin of uncertainty in threshold measurements (6dB)

Results

Monitor threshold	Measured Threshold Level	Limit	Pass/Fail
Lower Threshold (dBm)	-77.13 dBm	-74.13 dBm	Pass

22 Monitoring of Intended Transmit Window & Maximum Reaction Time

22.1 Definition

The reaction time is the minimum duration of the interference present during the monitoring interval that must be detected by the EUT so as to determine that the monitored time and spectrum window is occupied.

22.2 Test Parameters

Measurement standard	ANSI C63.17 sub-clause 7.5
Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
EUT Channels / Frequencies Measured:	f1 - 1923.264 MHz ; f2 – 1926.720MHz

Environmental Conditions (Normal Environment)

Temperature: 22 °C	+15 ºC to +35 ºC (as declared)
Humidity: 42 % RH	20 % RH to 75 % RH (as declared)

22.3 Test Method

The EUT was restricted to operation on two channels. The interference generator was fed pulses from the function generator to produce a pulsed carrier of the specified time length and the output of the interference generator was set to the required level. The pulse generator and companion device were synchronized so the position of the pulses corresponded to the time-slot pattern in the frame of the EUT.

For each of the required tests the pulse width and interference level are as below:

Test c)

Apply time-synchronized, pulsed interference on *f*1 at the pulsed level $T_L + U_M$ to the receive port of the EUT the width of the pulse the largest of 50µs and $50\sqrt{1.25/B}$ µs . Additionally apply a CW signal on f_2 at the level T_L to the receive port of the EUT. Verify that the EUT establishes a connection only on f_2.

Test d)

Apply time-synchronized, pulsed interference on *f*1 at the pulsed level $T_L + U_M$ to the receive port of the EUT the width of the pulse the largest of 35µs and $35\sqrt{1.25/B}$. Additionally apply a CW signal on f_2 at the level T_L to the receive port of the EUT. Verify that the EUT establishes a connection only on f_2.

Where B = Emission bandwidth of the EUT in MHz

22.4 Test Results

Test Equation (µs)	Pulse Width (µs)	f_1 Interferer Level (dBm)	f_2 Interferer Level (dBm)	EUT transmission Frequency	Pass/Fail
$50\sqrt{1.25/B}$	50µs	$T_L + U_m$	T_L	f_2	Pass
$35\sqrt{1.25/B}$	35µs	$T_L + U_m + 6$	T_L	f_2	Pass

Notes:
1. T_L is the calculated Lower threshold.
2. U_M is Margin of uncertainty in threshold measurements (6dB).

23 Monitoring Bandwidth & Antenna

23.1 Definition

The methods implemented for checking whether the spectrum is occupied or not.

23.2 Test Limit

ANSI C63.17 sub-clause 7.4 states that if the monitoring is made through the radio receiver used by the EUT for communication the intended bandwidth requirements for the monitoring system are met.

23.3 Test Results

The monitoring bandwidth test was carried out in accordance with ANSI C63.17 sub-clause 7.4.

23.3.1 Monitoring Bandwidth

As declared by the manufacturer the EUT uses the radio receiver used for communication for monitoring therefore the intended bandwidth requirements for the monitoring system are met of ANSI C63.17 sub-clause 7.4 are met.

23.3.2 Monitoring Antenna

The antenna of the EUT used for transmitting is the same antenna that is used for monitoring.

24 Power Accuracy

24.1 Definition

Checks that a power level can be determined within a set margin.

24.2 Test Limit

The power measurement resolution for the previous comparison must be accurate to within 6dB.

24.3 Test Results

The monitoring threshold test covered in Part 15.323 (c)(2) automatically proves that this requirement is met.

25 Segment Occupancy

25.1 Definition

To ensure that any group of devices does not utilise more than a maximum amount of time / spectrum

25.2 Test Limit

No device or group of co-operating devices located within 1 m of each other shall, during any frame period, occupy more than 6 MHz of aggregate bandwidth, or alternatively, more than one third of the time and spectrum windows defined by the system.

25.3 Test Results (Declaration)

Manufacturer declares “Device can only transmit on 1 of the 5 available frequencies at a time. Well below one third”

26 Duration Of Transmission

26.1 Definition

The amount of time a device uses a channel without repeating access criteria

26.2 Test Parameters

Measurement standard	ANSI C63.17 sub-clause 8.2.2
Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab

Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 ºC to +35 ºC (as declared)
Humidity: 44 % RH	20 % RH to 75 % RH (as declared)

26.3 Test Limit

The EUT shall not continue to use the same channel without executing the access criteria at least as often as every 8 hours.

26.4 Test Results

Repetition of Access Criteria	Maximum Transmission Time (Hours:Minutes:Seconds)	Maximum Transmission Time Limit	Pass/Fail
Period	3:51:37	<8 Hours	Pass

27 Connection Acknowledgement

27.1 Definition

To verifies that the two devices communicating over a duplex connection comply with the access criteria.

27.2 Test Parameters

Measurement standard	ANSI C63.17 sub-clause 8.2.1
Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
EUT Channels / Frequencies Measured:	1924.992 MHz

Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 ºC to +35 ºC (as declared)
Humidity: 44 % RH	20 % RH to 75 % RH (as declared)

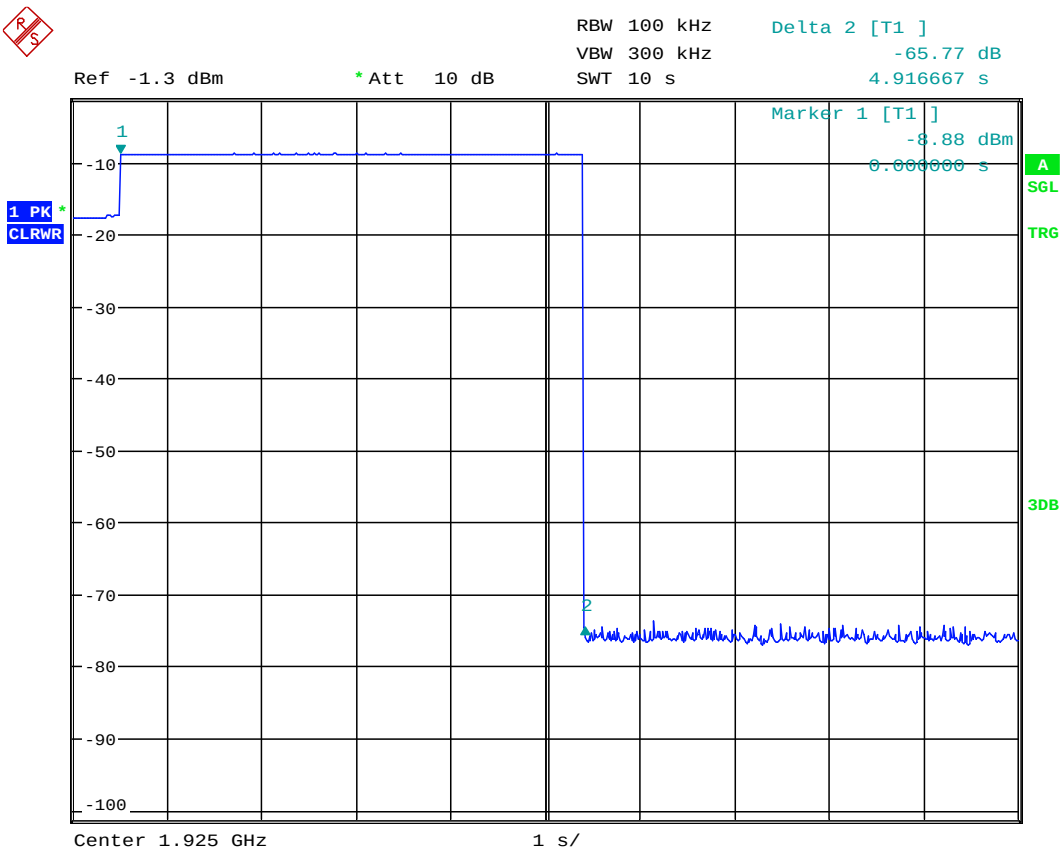
27.3 Test Method

The test was carried out in two parts. The first was to verify that with the companion device off (no initial acknowledgement received) the EUT does not transmit on the same time/spectrum window for more than the limit. The second was to verify that after a connection is broken the EUT terminates its transmission on the current communication channel within 30 seconds or less.

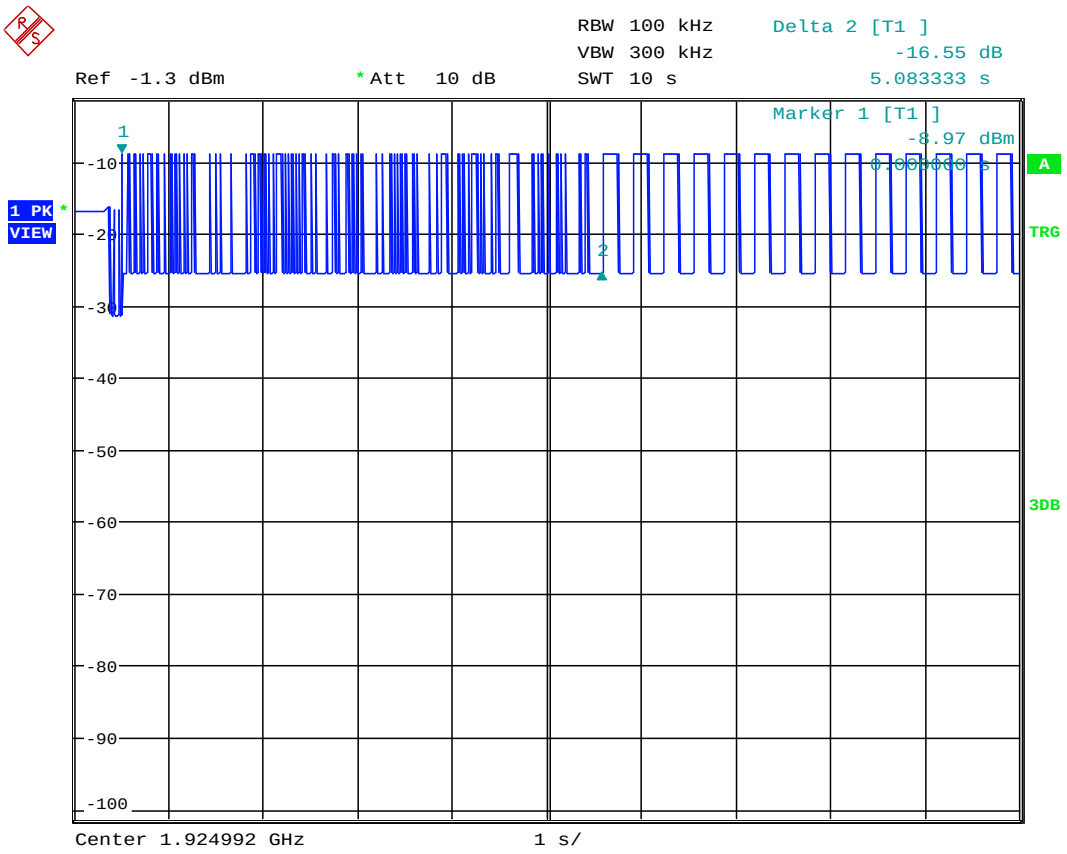
27.4 Test Results

Test	Time Taken (seconds)	Limit (seconds)	Pass/Fail
Transmission on communications channel no acknowledgement received (note 1)	The EUT does not transmit	1	Pass
EUT starting Activation, acknowledgement blocked from companion	4.9167	30	Pass
EUT responding to Activation, acknowledgement blocked from companion	5.0833	30	Pass

Note: 1. The companion device transmits a beacon signal when acknowledgements are blocked.
2. The EUT does not transmit a control channel.



Activating EUT, acknowledgement blocked (Mkr1) from companion



Responding EUT, acknowledgement blocked (Mkr1) from companion

28 Least Interfered Channel (LIC) Procedure

28.1 Definition

To determine that an EUT is operating in the LIC mode can properly select the channel with the lowest interference power, within a 6 dB resolution

28.2 Test Parameters

Measurement standard	ANSI C63.17 sub-clause 7.3.2
Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
EUT Channels / Frequencies Measured:	1923.264 MHz (f1) / 1924.992 MHz (f2)

Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 ºC to +35 ºC (as declared)
Humidity: 44 % RH	20 % RH to 75 % RH (as declared)

28.3 Test Method

The EUT utilizes more than 40 channels; therefore the least interfered channel testing is applicable.

The EUT was restricted to operating on two frequencies only, designated f1 and f2.

Test b)
Interference on f1 was set at $T_L + U_M + 7dB$ and at $T_L + U_M$ on f2. Initiate communication. The EUT should transmit on f2. Repeat 5 times. If the EUT transmits on f1 the test is failed.

Test c)
Interference on f1 was set at $T_L + U_M$ and at $T_L + U_M + 7dB$ on f2. Initiate communication. The EUT should transmit on f1. Repeat 5 times. If the EUT transmits on f2 the test is failed.

Test d)
Interference on f1 was set at $T_L + U_M + 1dB$ and at $T_L + U_M - 6dB$ on f2. Initiate communication. The EUT should transmit on f2. Repeat 5 times. If the EUT transmits on f1 the test is failed.

Test e)
Interference on f1 was set at $T_L + U_M - 6dB$ and at $T_L + U_M + 7dB$ on f2. Initiate communication. The EUT should transmit on f1. Repeat 5 times. If the EUT transmits on f2 the test is failed.

28.4 Test Results

Test	Transmit on f1	Transmit on f2	Wanted Transmit Channel (If any TX)	Pass/Fail
b	No	No	f2	Pass
c	No	No	f1	Pass
d	No	Yes	f2	Pass
e	Yes	No	f1	Pass

Note: 1. All tests were repeated 5 times.

29 Selected Channel Confirmation

29.1 Definition

To determine that an EUT monitors the selected channel immediately prior to transmission. The test described as follows is intended to verify that the EUT makes its channel selection decision on the basis of a recent power level reading

29.2 Test Parameters

Measurement standard	ANSI C63.17 sub-clause 7.3.3
Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
EUT Channels / Frequencies Measured:	1923.264 MHz (f1) / 1924.992 MHz (f2)

Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 ºC to +35 ºC (as declared)
Humidity: 44 % RH	20 % RH to 75 % RH (as declared)

29.3 Test Method

The EUT was Restricted to operating on two frequencies only, f1 and f2.

Test a)
Interference is applied on f1 at a level of T_L + U_M + 20 dB. Verify a connection is established on f2.

Any connection is terminated.

Test b)
Interference is applied on f2 at a level of T_L + U_M + 20 dB and immediately removed from f1 and the EUT is immediately caused to attempt transmission. In this case the EUT should transmit on f1

The test is applied in both single and long slot configurations.

29.4 Test Results

Test	Transmit on f1	Transmit on f2	Wanted Transmit Channel (If Any TX)	Pass/Fail
a	No	Yes	f2	Pass
b	No	No	f1	Pass

30 Duplex Connections

30.1 Definition

To determine that an EUT monitors the selected channel immediately prior to transmission. The test described as follows is intended to verify that the EUT makes its channel selection decision on the basis of a recent power level reading

30.2 Test Parameters

Measurement standard	ANSI C63.17 sub-clause 8.3.2
Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
EUT Channels / Frequencies Measured:	1924.992 MHz
Interference Free Receive slots:	2 & 3
Interference Free Transmit slots:	10 & 11

Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 ºC to +35 ºC (as declared)
Humidity: 44 % RH	20 % RH to 75 % RH (as declared)

30.3 Test Method

Before all tests are carried out any connection is terminated.

Test b)
The system is restricted to operation on one frequency (1924.992 MHz) using administration. Verify that a connection between the EUT and its companion device can be made.

Test c) & d)
Apply interference at a level $T_L + U_M$ to all receive time slots except one which has interference at least 10dB below T_L. Apply interference at a level $T_L + U_M$ to all transmit time slots. Cause the EUT to attempt to establish a connection. If a connection is established the test is failed.

Test e) & f)
Apply interference at a level $T_L + U_M$ to all transmit time slots except one which has interference at least 10dB below T_L. Apply interference at a level $T_L + U_M$ to all receive time slots. Cause the EUT to attempt to establish a connection. If a connection is established the test is failed.

30.4 Test Results

Test	Connection Made	Pass/Fail
b	Yes	Pass
c & d	No	Pass
e & f	No	Pass

31 Emissions Inside and Outside the Sub-Band - Conducted

31.1 Definition

In-Band Emissions
Emission on a frequency or frequencies immediately outside the necessary bandwidth that results from the modulation process but excluding spurious emissions.

Out-of-band emission.
Emission on a frequency or frequencies immediately outside the operating band that results from the modulation process but excluding spurious emissions.

Spurious emission.
Emission on a frequency or frequencies that are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products, and frequency conversion products, but exclude in-band and out-of-band emissions.

31.2 Test Parameters

Measurement standard	ANSI C63.17 sub-clause 6.1.6
Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
EUT Channels / Frequencies Measured:	1921.536 MHz / 1928.448 MHz

31.3 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure v, the emissions from the EUT were measured on a spectrum analyser.

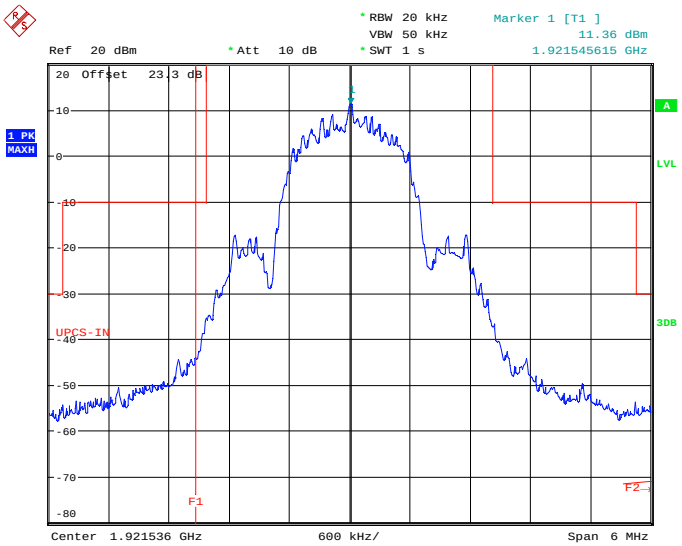
The measurements were performed with EUT set at its maximum duty. All modulation schemes, data rates and power settings were used to observe the worst case configuration in each bandwidth.

31.4 Test Results

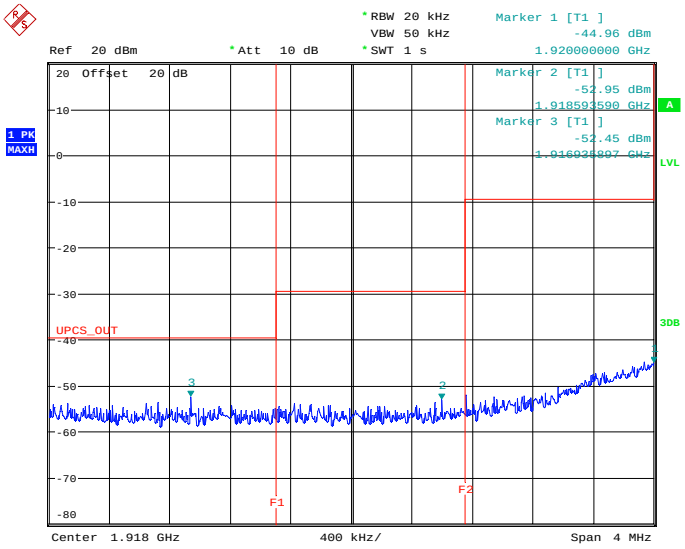
RF carrier set to the lowest carrier defined by the EUT					
Out-of-Band Emissions from UPCS bandedge	**FREQ. (MHz)**	**MEAS. Rx. (dBm)**	**CABLE & ATTEN. LOSS (dB)**	**EMISSION LEVEL (dBm)**	**LIMIT (dBm)**
> - 2.5MHz	Not Applicable – Radiated testing performed				
- 1.25 MHz – 2.5 MHz	1918.594	-72.95	20	-52.95	-29.5
- 1.25 MHz	1920.000	-64.96	20	-44.96	-9.5
In-band Emissions	See plot				
+ 1.25 MHz	1930.108	-79.36	20	-59.36	-9.5
+ 1.25 MHz – 2.5 MHz	1931.884	-73.03	20	-53.03	-29.5
> + 2.5MHz	Not Applicable – Radiated testing performed				

Limits	**Out-of-Band Emissions From UPCS bandedge**	**Attenuation (dB) required below Reference power of 112mW**
	± 1.25MHz	30
	±1.25 MHz – 2.5 MHz	50
	> ±2.5MHz	60
	In band Emissions from centre of emission bandwidth	**Attenuation (dB) required below permitted peak power for the EUT**
	1B – 2B	30
	2B – 3B	50
	3B – UPCS band edge	60

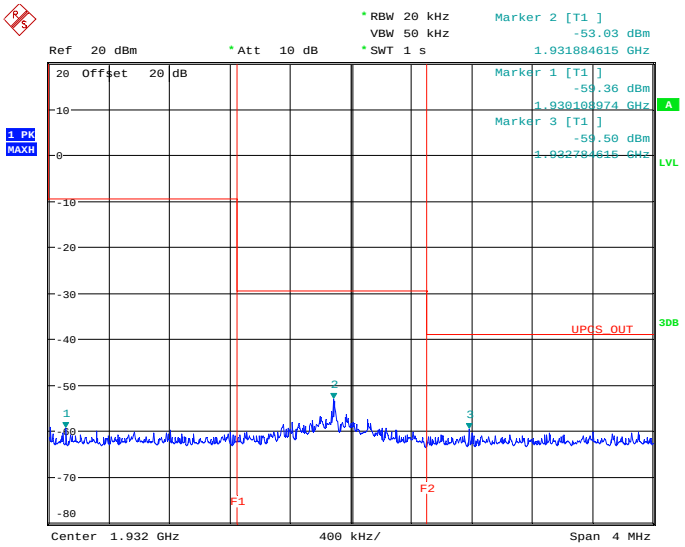
Emissions inside the Sub-Band RF carrier set to the lowest carrier defined by the EUT



Conducted Emissions outside the Sub-Band RF carrier set to the lowest carrier defined by the EUT



Lower Bandedge - > 2.5MHz

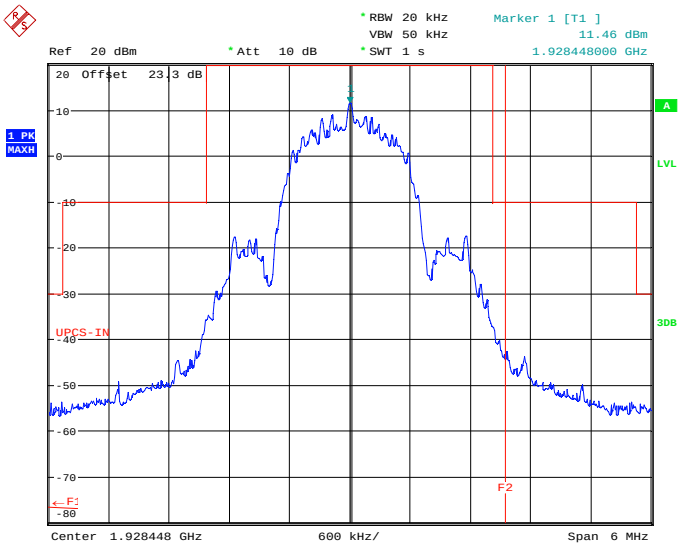


Upper Bandedge - > 2.5MHz

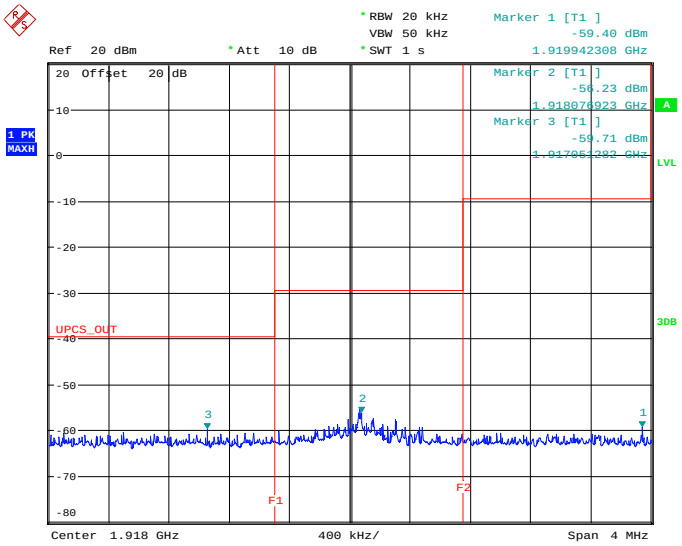
RF carrier set to the highest carrier defined by the EUT					
Out-of-Band Emissions from UPCS bandedge	**FREQ. (MHz)**	**MEAS. Rx. (dBm)**	**CABLE & ATTEN. LOSS (dB)**	**EMISSION LEVEL (dBm)**	**LIMIT (dBm)**
> - 2.5MHz	Not Applicable – Radiated testing performed				
- 1.25 MHz – 2.5 MHz	1918.077	-76.23	20	-56.23	-29.5
- 1.25 MHz	1919.942	-79.40	20	-59.40	-9.5
In-band Emissions	See plot				
+ 1.25 MHz	1930.128	-63.49	20	-43.49	-9.5
+ 1.25 MHz – 2.5 MHz	1931.469	-74.41	20	-54.41	-29.5
> + 2.5MHz	Not Applicable – Radiated testing performed				

Limits	**Out-of-Band Emissions From UPCS bandedge**	**Attenuation (dB) required below Reference power of 112mW**
	± 1.25MHz	30
	±1.25 MHz – 2.5 MHz	50
	> ±2.5MHz	60
	In band Emissions from centre of emission bandwidth	**Attenuation (dB) required below permitted peak power for the EUT**
	1B – 2B	30
	2B – 3B	50
	3B – UPCS band edge	60

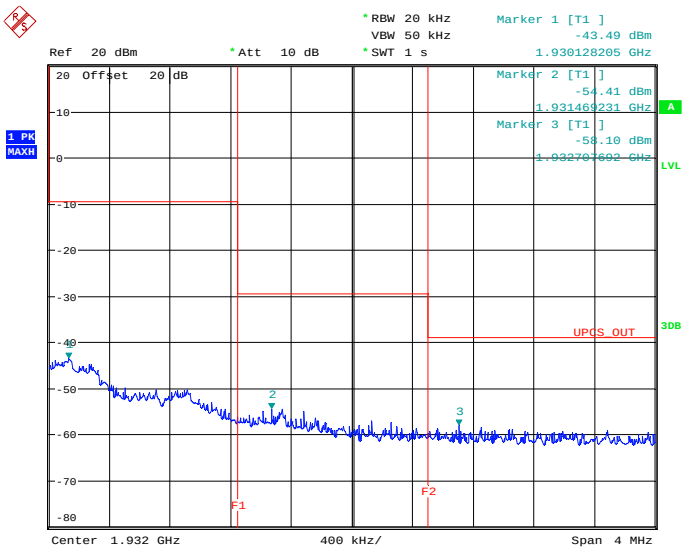
Emissions inside the Sub-Band RF carrier set to the highest carrier defined by the EUT



Conducted Emissions outside the Sub-Band RF carrier set to the highest carrier defined by the EUT



Lower Bandedge - > 2.5MHz



Upper Bandedge - > 2.5MHz

32 Emissions Inside and Outside the Sub-Band - Radiated

32.1 Definition

In-Band Emissions
Emission on a frequency or frequencies immediately outside the necessary bandwidth that results from the modulation process but excluding spurious emissions.

Out-of-band emission.
Emission on a frequency or frequencies immediately outside the operating band that results from the modulation process but excluding spurious emissions.

Spurious emission.
Emission on a frequency or frequencies that are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products, and frequency conversion products, but exclude in-band and out-of-band emissions.

32.2 Test Parameters

Test Standard and Clause:	ANSI C63.17 sub-clause 6.1.6. ANSI C63.10-2013, Clause 6.5 and 6.6
Test Location:	Element Skelmersdale
Test Chamber:	Radio Chamber
EUT Channels / Frequencies Measured:	Low / High
Deviations From Standard:	None
Measurement BW:	30 MHz to 1 GHz: 120 kHz Above 1 GHz: 1 MHz
Measurement Detector:	Up to 1 GHz: quasi-peak Above 1 GHz: RMS average and Peak

Environmental Conditions (Normal Environment)

Temperature: 22 °C	+15 ºC to +35 ºC (as declared)
Humidity: 32 % RH	20 % RH to 75 % RH (as declared)

32.3 Test Limit

Emissions from license-exempt transmitters shall comply with the field strength limits shown in the table below. Additionally, the level of any transmitter emission shall not exceed the level of the transmitter's fundamental emission.

General Field Strength Limits for License-Exempt Transmitters at Frequencies above 30 MHz

Frequency (MHz)	*Field Strength (µV/m at 3 m)*
30 to 88	100
88 to 216	150
216 to 960	200
Above 960	500

32.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure ii, the emissions from the EUT were measured on a spectrum analyzer / EMI receiver.

Radiated electromagnetic emissions from the EUT are checked first by preview scans. Preview scans for all spectrum and modulation characteristics are checked, using a peak detector and where applicable worst-case determined for function, operation, orientation, etc. for both vertical and horizontal polarisations. Pre-scan plots are shown with a peak detector and 100 kHz RBW.

If the EUT connects to auxiliary equipment and is table or floor standing, the configurations prescribed in ANSI C63.10 are followed. Alternatively, a layout closest to normal use (as declared by the provider) is employed, (see EUT setup photographs for more detail).

Emissions between 30 MHz and 1 GHz are measured using calibrated broadband antennas. Emissions above 1 GHz are characterized using standard gain horn antennas. Pre-amplifiers and filters are used where required. Care is taken to ensure that test receiver resolution bandwidth, video bandwidth and detector type(s) meet the regulatory requirements.

For both horizontal and vertical polarizations, the EUT is then rotated through 360 degrees in azimuth until the highest emission is detected. At the previously determined azimuth the test antenna is raised and lowered from 1 to 4 m in height until a maximum emission level is detected, this maximum value is recorded.

Power values measured on the test receiver / analyzer are converted to field strength, FS, in dBµV/m at the regulatory distance, using:

$$FS = PR + CL + AF - PA + DC - CF$$
$$Factor = CL + AF - PA$$

Where,

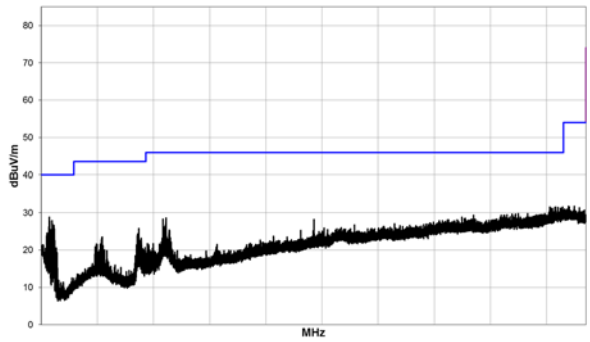
PR is the power recorded on the receiver / spectrum analyzer in dBµV;
CL is the cable loss in dB;
AF is the test antenna factor in dB/m;
PA is the pre-amplifier gain in dB (where used);
DC is the duty correction factor in dB (where used, e.g. harmonics of pulsed fundamental);
CF is the distance factor in dB (where measurement distance is different to limit distance);

This field strength value is then compared with the regulatory limit.

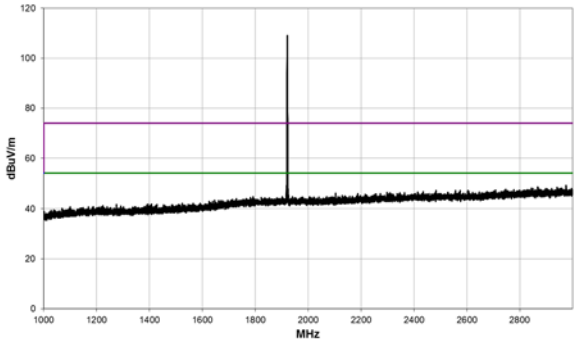
Figure ii Test Setup

32.5 Test Results

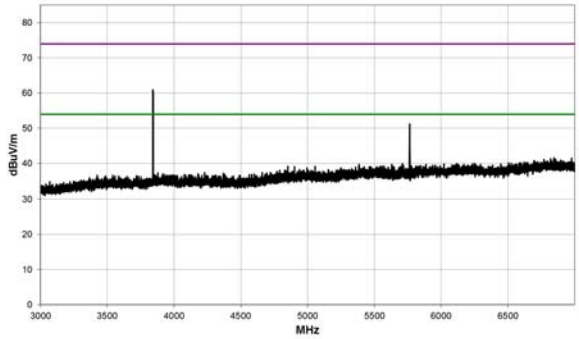
RF carrier set to the lowest carrier defined by the EUT											
Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	Test Distance (meters)	POL	DET	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)
49.33	34.6	-14.1	1.1	155.0	3.0	Vert	QP	0.0	20.5	40.0	-19.5
252.03	30.2	-8.3	1.05	17.0	3.0	Vert	QP	0.0	21.9	46.0	-24.1
3842.69	64.9	2.3	1.75	235.9	3.0	Vert	PK	0.0	67.2	74.0	-6.8
3842.67	63.5	2.3	1.77	147.9	3.0	Horz	PK	0.0	65.8	74.0	-8.2
3843.01	36.7	2.3	1.75	235.9	3.0	Vert	AV	0.0	39.0	54.0	-15.0
3843.01	35.9	2.3	1.77	147.9	3.0	Horz	AV	0.0	38.2	54.0	-15.8
7684.71	57.9	8.1	1.5	227.0	1.0	Vert	PK	-9.5	56.5	74.0	-17.5
7684.86	57.6	8.1	1.5	68.0	1.0	Horz	PK	-9.5	56.2	74.0	-17.8
7687.36	32.8	8.1	1.5	227.0	1.0	Vert	AV	-9.5	31.4	54.0	-22.6
7687.36	32.6	8.1	1.5	68.0	1.0	Horz	AV	-9.5	31.2	54.0	-22.8



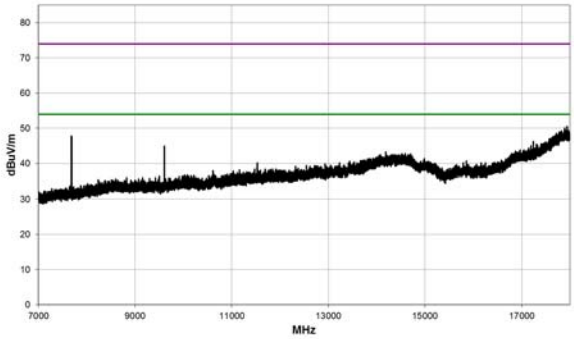
30 MHz – 1000 MHz



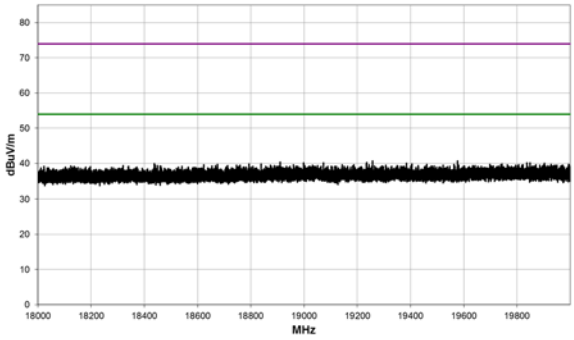
1 GHz – 3 GHz



3 GHz – 7 GHz

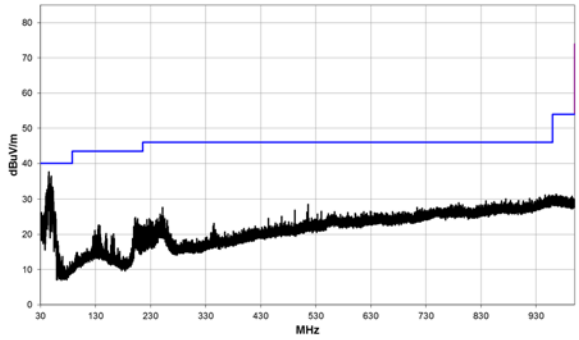


7 GHz – 18 GHz

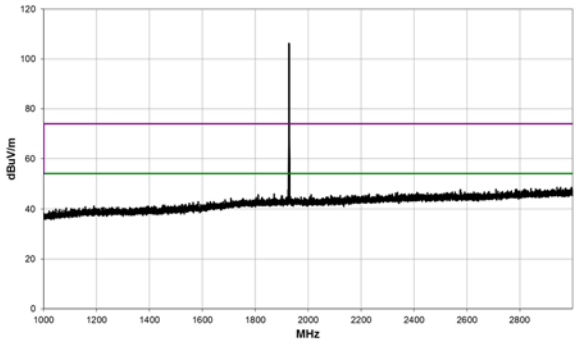


18 GHz – 20 GHz

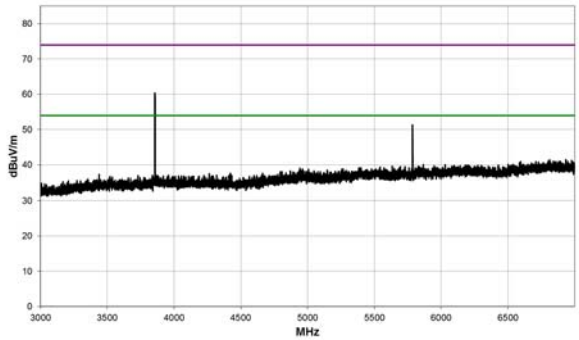
RF carrier set to the Highest carrier defined by the EUT											
Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	Test Distance (meters)	POL	DET	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)
49.352	36.5	-14.1	1.58	231.0	3.0	0.0	Vert	QP	0.0	22.4	40.0
252.027	27.7	-8.3	1.58	0.0	3.0	0.0	Vert	QP	0.0	19.4	46.0
3856.493	64.5	2.4	1.19	5.0	3.0	0.0	Vert	PK	0.0	66.9	74.0
3856.293	63.5	2.4	1.77	148.9	3.0	0.0	Horz	PK	0.0	65.9	74.0
3856.810	36.5	2.4	1.19	5.0	3.0	0.0	Vert	AV	0.0	38.9	54.0
3856.727	36.0	2.4	1.77	148.9	3.0	0.0	Horz	AV	0.0	38.4	54.0
7712.763	56.7	8.1	1.54	228.0	1.0	0.0	Vert	PK	-9.5	55.3	74.0
7712.997	56.3	8.1	1.5	79.0	1.0	0.0	Horz	PK	-9.5	54.9	74.0
7714.930	32.2	8.1	1.54	228.0	1.0	0.0	Vert	AV	-9.5	30.8	54.0
7714.930	32.0	8.1	1.5	79.0	1.0	0.0	Horz	AV	-9.5	30.6	54.0



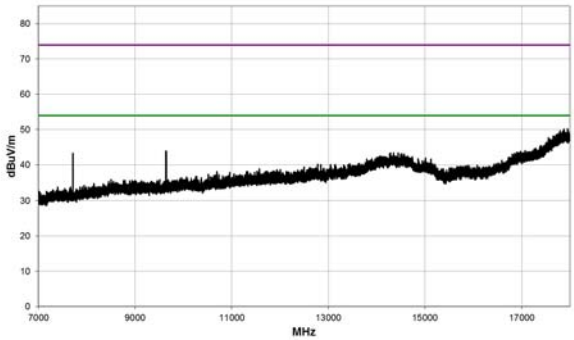
30 MHz – 1000 MHz



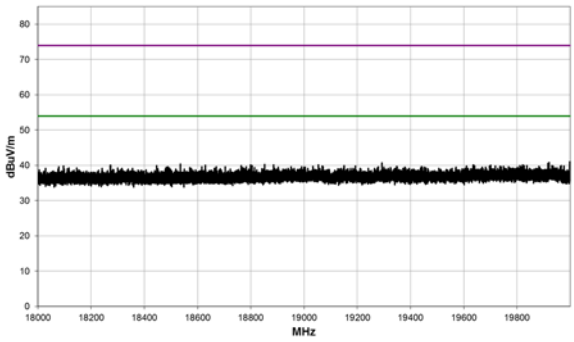
1 GHz – 3 GHz



3 GHz – 7 GHz



7 GHz – 18 GHz



18 GHz – 20 GHz

33 Frame Repetition Stability

33.1 Definition

This is the mean value of the frame repetition rate recorded over 1000 samples.

33.2 Test Parameters

Test Standard and Clause:	ANSI C63.17 sub-clause 6.2.2
Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
EUT Channels / Frequencies Measured:	1924.992 MHz
Deviations From Standard:	None

Environmental Conditions (Normal Environment)

Temperature: 22 °C	+15 ºC to +35 ºC (as declared)
Humidity: 32 % RH	20 % RH to 75 % RH (as declared)

33.3 Test Limit

Each device that implements time division for the purpose of maintaining a duplex connection on a given frequency carrier shall maintain a frame repetition rate with a frequency stability of at least 50 parts per million (ppm).

Each device that further divides access in time in order to support multiple communication links on a given frequency carrier shall maintain a frame repetition rate with a frequency stability of at least 10 ppm.

33.4 Test Result

Frame Repetition Stability (ppm)	Limit (ppm)	Pass/Fail
0	±10ppm	PASS

34 Frame Period and Jitter

34.1 Definition

Jitter is the difference in time between the rising edges of consecutive pulses occurring due to time-related, abrupt, spurious variations in the duration of the frame interval

34.2 Test Parameters

Test Standard and Clause:	ANSI C63.17 sub-clause 6.2.3
Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
EUT Channels / Frequencies Measured:	1924.992 MHz
Deviations From Standard:	None

Environmental Conditions (Normal Environment)

Temperature: 22 °C	+15 ºC to +35 ºC (as declared)
Humidity: 32 % RH	20 % RH to 75 % RH (as declared)

34.3 Test Limit

The jitter introduced at the 2 ends of a communication link shall not exceed 25 µs for any 2 consecutive transmissions.

34.4 Test Result

Maximum Positive Jitter (µs)	Maximum Negative Jitter (µs)	3xSD Jitter (µs)	Frame period (ms)	Limit (µs)		Pass/ Fail
				Frame Period (ms)	Jitter (µs)	
0.05	-0.07	0.21	10.00021	20 or 10/X	25	Pass

35 Frequency Stability

35.1 Definition

The accuracy of the transmitted signal, This testing is carried out with the following conditions over 1000 samples.

35.2 Test Parameters

Test Standard and Clause:	ANSI C63.17 sub-clause 6.2.1
Test Location:	Element Skelmersdale
Test Chamber:	Radio Chamber
EUT Channels / Frequencies Measured:	1924.992 MHz

Environmental Conditions (Normal Environment)

Temperature: 22 °C	+15 ºC to +35 ºC (as declared)
Humidity: 32 % RH	20 % RH to 75 % RH (as declared)

35.3 Test Limit

The carrier frequency stability shall be maintained within ±10 ppm (±0.001%).

35.4 Test Results

Temperature (°C)	Voltage (Vdc)	Fc (MHz)	offset (kHz)	offset (ppm)	Limit (ppm)
+20	Vnom	1924.992	-13	6.75	±10ppm
-20	Vnom	1924.992	-7	3.64	±10ppm
+55	Vnom	1924.992	-8	4.16	±10ppm

Note: 1. The EUT is battery powered therefore voltage variations are not required.
2. Frequency variation relative to EUT operating Frequency.

37 Test Equipment

Equipment Description	*Manufacturer*	*Equipment Type*	*Element No*	*Last Cal Calibration*	*Calibration Period*	*Due For Calibration*
Spectrum Analyser	R&S	FSU46	REF910	2019-10-17	12	2020-10-17
Vector Signal Generator	HP	ESG-D E4433B	REF2195	2019-04-30	12	2020-04-30
Digital Signal Generator	Agilent	ESG D3000A	RFG441			
Temperature Indicator	Fluke	52 Series II	L426	2019-06-28	12	2020-06-28
Temperature Chamber	Votsch	VT 4002	U521	Use L426		
Radiocommunication Tester	R&S	CMD 60	RFG433	2019-07-30	12	2020-07-30
1-18GHz Horn	EMCO	3115	L139	2019-07-16	24	2021-07-16
Pre Amp	Agilent	8449B	L572	2019-10-15	12	2020-10-15
Bilog	Chase	CBL611/A	U573	2019-09-19	24	2021-09-19
Horn 18-26GHz (&U330)*	Flann	20240-20	L300	2018-04-24	24	2020-04-24
Radio Chamber - PP	Rainford EMC	ATS	REF940	2019-12-09	24	2021-12-09
Spectrum Analyser	R&S	FSU26	U405	2019-10-21	12	2020-10-21
Multimeter	Agilent	34405a	REF976	2019-11-21	12	2020-11-21
Power Supply	ISO-Tech	IPS-303DD	U515	Use REF976		

* Equipment was in calibration when used during the test schedule

38 Measurement Uncertainty

Calculated Measurement Uncertainties

All statements of uncertainty are expanded standard uncertainty using a coverage factor of 1.96 to give a 95 % confidence:

[1] Adjacent Channel Power

Uncertainty in test result = **1.86dB**

[2] Carrier Power

Uncertainty in test result (Power Meter) = **1.08dB**
Uncertainty in test result (Spectrum Analyser) = **2.48dB**

[3] Effective Radiated Power

Uncertainty in test result = **4.71dB**

[4] Spurious Emissions

Uncertainty in test result = **4.75dB**

[5] Maximum frequency error

Uncertainty in test result (Frequency Counter) = **0.113ppm**
Uncertainty in test result (Spectrum Analyser) = **0.265ppm**

[6] Radiated Emissions, field strength OATS 14kHz-18GHz Electric Field

Uncertainty in test result (14kHz – 30MHz) = **4.8dB**,
Uncertainty in test result (30MHz – 1GHz) = **4.6dB**,
Uncertainty in test result (1GHz – 18GHz) = **4.7dB**

[7] Frequency deviation

Uncertainty in test result = **3.2%**

[8] Magnetic Field Emissions

Uncertainty in test result = **2.3dB**

[9] Conducted Spurious

Uncertainty in test result – Up to 8.1GHz = **3.31dB**
Uncertainty in test result – 8.1GHz – 15.3GHz = **4.43dB**
Uncertainty in test result – 15.3GHz – 21GHz = **5.34dB**
Uncertainty in test result – Up to 26GHz = **3.14dB**

[10] Channel Bandwidth

Uncertainty in test result = **15.5%**

[11] Amplitude and Time Measurement – Oscilloscope

Uncertainty in overall test level = **2.1dB**,
Uncertainty in time measurement = **0.59%,**
Uncertainty in Amplitude measurement = **0.82%**

[12] Power Line Conduction

Uncertainty in test result = **3.4dB**

[13] Spectrum Mask Measurements

Uncertainty in test result = **2.59% (frequency)**
Uncertainty in test result = **1.32dB (amplitude)**

[14] Adjacent Sub Band Selectivity

Uncertainty in test result = **1.24dB**

[15] Receiver Blocking – Listen Mode, Radiated

Uncertainty in test result = **3.42dB**

[16] Receiver Blocking – Talk Mode, Radiated

Uncertainty in test result = **3.36dB**

[17] Receiver Blocking – Talk Mode, Conducted

Uncertainty in test result = **1.24dB**

[18] Receiver Threshold

Uncertainty in test result = **3.23dB**

[19] Transmission Time Measurement

Uncertainty in test result = **7.98**